Marshall

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON, D.C. 20546

JAN 29 1975

REPLY TO ATTN OF: GP

TO: KSI/Scientific & Technical Information Division
Attn: Miss Winnie M. Morgan

FROM: GP/Office of Assistant General Counsel for Patent Matters

SUBJECT: Announcement of NASA-Owned U.S. Patents in STAR

In accordance with the procedures agreed upon by Code GP and Code KSI, the attached NASA-owned U.S. Patent is being forwarded for abstracting and announcement in NASA STAR.

The following information is provided:

U.S. Patent No. : 3,859,840

Government or Corporate Employee : U.S. Government

Supplementary Corporate Source (if applicable) : ~

NASA Patent Case No. : MFS-21,045-1

NOTE - If this patent covers an invention made by a corporate employee of a NASA Contractor, the following is applicable:

YES ☐ NO ☒

Pursuant to Section 305(a) of the National Aeronautics and Space Act, the name of the Administrator of NASA appears on the first page of the patent; however, the name of the actual inventor (author) appears at the heading of column No. 1 of the Specification, following the words "...with respect to an invention of ..."

Bonnie L. Woerner

Bonnie L. Woerner
Enclosure

MFS-21045-1

United States Patent [19]

Gause

[11] **3,859,840**

[45] **Jan. 14, 1975**

[54] **ERGOMETER CALIBRATOR**

[75] Inventor: **Raymond L. Gause**, Huntsville, Ala.

[73] Assignee: **The United States of America as represented by the Administrator of the National Aeronautics and Space Administration**, Washington, D.C.

[22] Filed: **Oct. 31, 1973**

[21] Appl. No.: **411,572**

[52] **U.S. Cl.** ..... **73/1 R**, 73/379

[51] **Int. Cl.** **G01l 25/00**

[58] **Field of Search** ..... 73/1 R, 1 C, 379

[56] **References Cited**

UNITED STATES PATENTS

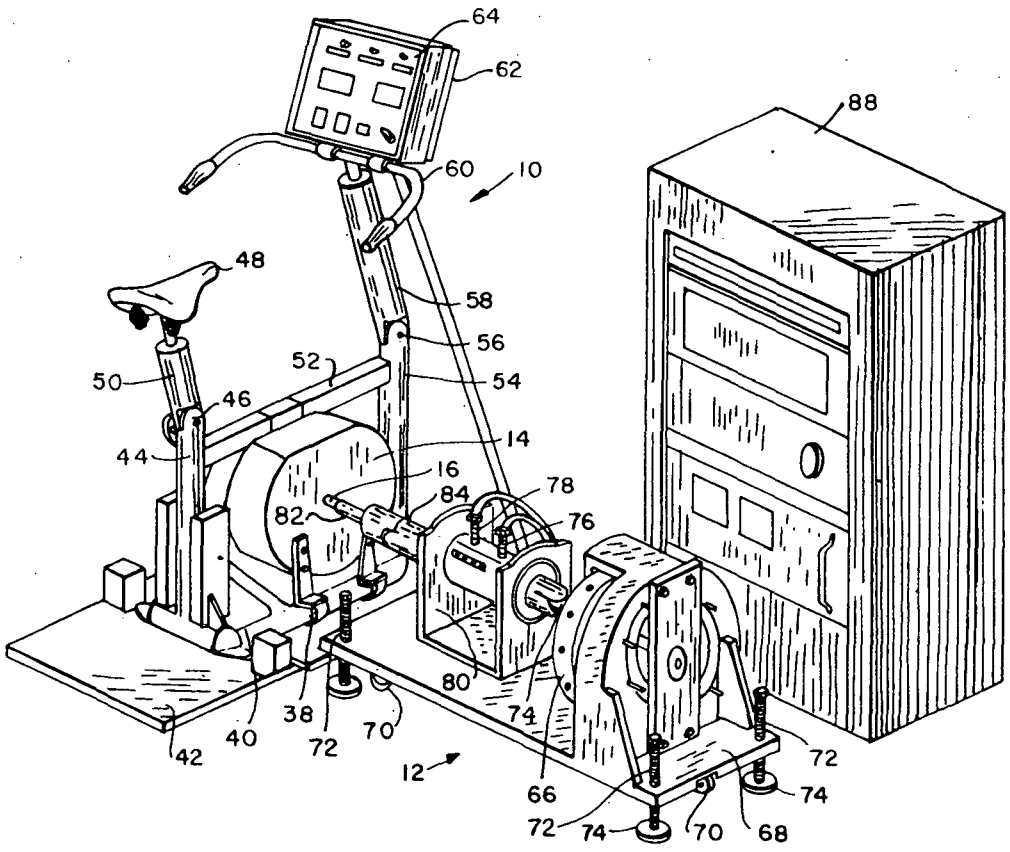
2,784,591	3/1957	Shoor	73/379
3,192,772	7/1965	Tarter	73/379
3,744,480	7/1973	Gause et al.	73/379 X

Primary Examiner—Richard C. Queisser
Assistant Examiner—Frederick Shoon
Attorney, Agent, or Firm—Wayland H. Riggins; L. D. Wofford, Jr.; John R. Manning

[57] **ABSTRACT**

An apparatus for accurately calibrating ergometers so that the work rate produced by the particular ergometer being calibrated is accurate. The apparatus includes a D.C. motor which is coupled directly to the ergometer for rotating such at various speeds. Positioned on the shaft between the D.C. motor and the ergometer is a torque sensor and tachometer, which feeds signals to a power computer for subsequent recording. A speed controller is utilized with the D.C. motor.

3 Claims, 3 Drawing Figures



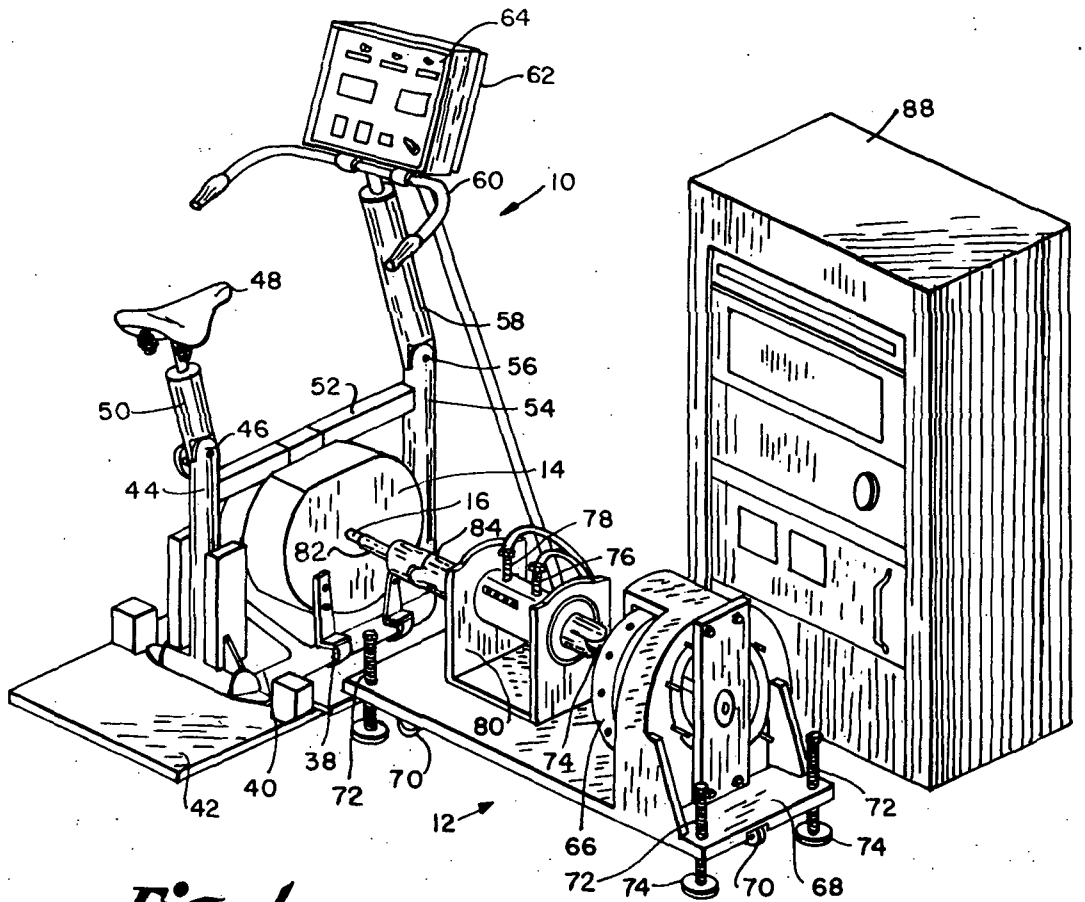


Fig. 1.

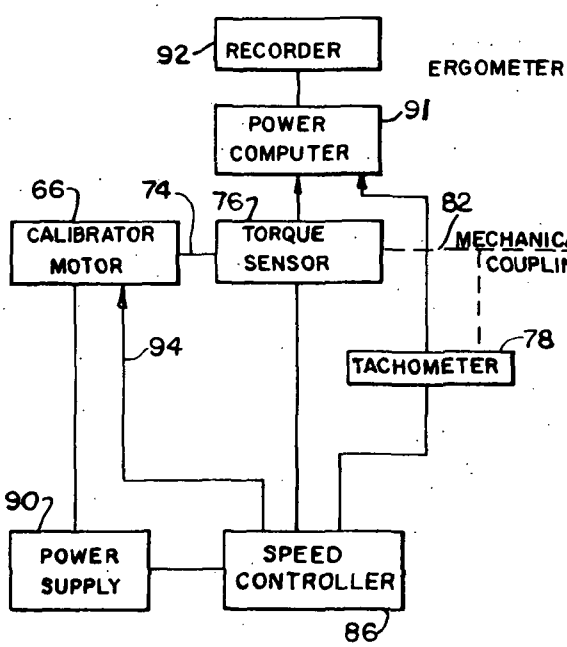


Fig. 2.

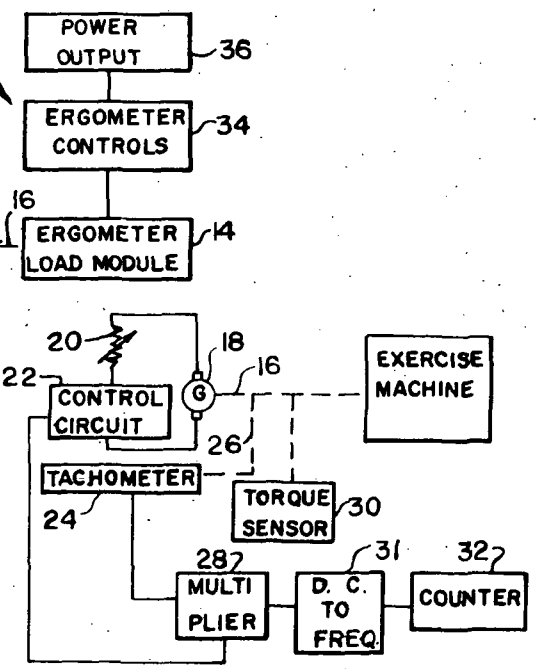


Fig. 3.

ERGOMETER CALIBRATOR

ORIGIN OF THE INVENTION

The invention described herein was made by an employee of the United States Government, and made be manufactured and used by or for the Government for governmental purposes without the payment of any royalties thereon or therefor.

BACKGROUND OF THE INVENTION

This invention relates generally to an apparatus for calibrating ergometers, and more particularly to an apparatus which generates electrical signals that can be compared with the output of an ergometer so as to determine if such is producing accurate and true output signals.

Ergometers are used in controlled stressing, conditioning or exercising of people, and are presently being utilized in many health institutions and exercising clinics. In some situations, such as when a patient is exercising as part of a recovery program associated with heart disease, it is important to know the exact amount of work that the patient is developing in peddling the ergometer. One device designed specifically for use in exercising heart patients is disclosed in U.S. Pat. No. 3,744,480, granted to Raymond L. Gause, et al., on July 10, 1973. Another instance where it is important to know the exact amount of work required to peddle an ergometer is in exercising astronauts while in outer space. It is important to record the work output of the astronauts so as to analyze such data to determine the exact amount of exercise needed to maintain the astronauts in proper physical condition. It has been determined that, if the astronauts do not receive sufficient exercise while in a zero gravity condition for an extended period of time, they develop a calcium deficiency in their bones.

Therefore, it can be seen that it is very important that the ergometer being utilized be accurately calibrated. Heretofore, the ergometers were statically calibrated using lever arms and weights. Such a calibration is not practical in all situations due to the time consumed for the calibration.

SUMMARY OF THE INVENTION

The invention is designed for providing a dynamic calibration over a given speed range for ergometers. One such ergometer is disclosed in U.S. Pat. No. 3,744,480 and includes peddles mounted on a rotatable shaft coupled to a D.C. generator. A variable resistance load is utilized for varying the torque required to rotate the D.C. generator. A torque sensor and tachometer are coupled to the shaft for sensing the rate of rotation and the amount of torque used for rotating the shaft. The signals from the tachometer and torque sensor are fed into a multiplier for producing a D.C. signal indicative of the work required to peddle the ergometer.

The apparatus constructed in accordance with the present invention includes a D.C. motor, which is coupled directly to the shaft upon which the peddles are used for rotating the ergometer. A torque sensor is coupled to the shaft which produces a torque signal indicating the torque required to rotate the shaft. A tachometer is also coupled to the shaft for generating an electrical signal indicating the speed of rotation of the shaft. The signals from the torque sensor and the tachometer are fed into a power computer which computes the wattage being used by the D.C. motor for rotating the D.C. generator forming part of the ergometer. A speed controller is coupled between the output of the tachometer and the D.C. motor for enabling the motor to be rotated through a given range of speeds and holding the speed of the motor constant at the various speeds. Thus, by comparing the output signal produced by the apparatus with the output signal produced by the ergometer it can be determined if the ergometer is accurately calibrated. The D.C. motor is mounted on a carriage so that such can be readily maneuvered for coupling to the rotatable shaft of the ergometer.

Accordingly, it is a general object of the present invention to provide an improved apparatus for calibrating ergometers over a predetermined speed range.

Another important object of the present invention is to provide a relatively simple system capable of producing a dynamic calibration of an ergometer over a given speed load.

Still another important object of the present invention is to provide an apparatus for calibrating ergometers which can be readily maneuvered closely adjacent an ergometer and attached thereto.

These and other objects and advantages of the invention will become apparent upon reference to the following specification, attendant claims and drawing.

BRIEF DESCRIPTION OF THE DRAWING

FIG. **1** is a perspective view of a conventional ergometer having a calibration device constructed in accordance with the present invention coupled thereto,

FIG. **2** is a block diagram of the calibration device constructed in accordance with the present invention, and

FIG. **3** is a block diagram illustrating the controls associated with the ergometer shown in FIG. **1.**

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring first to FIG. **1** of the drawing, there is illustrated an ergometer, generally designated by the reference character **10** coupled to an apparatus, generally designed by the reference character **12,** provided for calibrating the components of the ergometer so as to produce a true and accurate work output indication. The ergometer **10** may be any conventional ergometer, and the particular one illustrated is that disclosed in U.S. Pat. No. 3,744,480.

The ergometer **10** includes a load module **14** which in normal operation is driven by bicycle-type peddles mounted on a rotatable shaft **16.** The load module **14,** as seen in FIG. **3,** includes a D.C. motor operated as a generator **18** that has a variable load resistor **20** coupled thereto. The shaft **16** is coupled directly to the shaft of the generator so that when the shaft **16** is rotated by peddling, such in turn, causes the generator to be rotated. The load applied to the generator can be varied by adjusting the resistor **20.** Variable loading to the generator **18** is effected by the electrical resistor **20,** which can be switched on and off by a control circuit **22** in accordance with pulses of varying widths. The details of the control circuit **22** are described in the above-mentioned U.S. Pat. No. 3,744,480, and is merely shown in block form in the subject application to set forth one particular ergometer that may be calibrated by the subject invention.

A tachometer **24** is coupled to the D.C. generator **18** by a shaft diagrammatically illustrated by broken line **26,** and provides a speed output signal to one input of a multiplier **28.** A torque sensor **30** is mechanically connected to the shaft of the D.C. generator **18** for providing a torque signal representative of the torque applied by the operator of the exercise machine **10.** This torque signal is applied to a second input of the multiplier **28.** The multiplier **28** provides a direct current output representative of the rate of work being performed by the exercise machine **10.** Calibration of this output by the operator is such that an output of 5 volts is representative of the work rate of 300 watts. This output is indicated or read out by first converting it to a pulse frequency proportional to a voltage by a D.C. frequency converter **31,** and then applying the thus converted output to a counter **32,** which counts pulses for a predetermined period to derive a direct readout in watts. The circuitry thus described associated with the ergometer is represented in block form in FIG. **2** by the block **34** entitled ergometer control and the block **36** labeled power output.

Referring again to FIG. **1,** the load module **14** is suitably mounted on brackets **38** carried on horizontal frame members **40.** The horizontal frame members are in turn supported on a rectangular base plate **42.** Extending upwardly from the rectangular base plate **42** is a vertical column **44** that has a pivot joint **46** attached thereto. A seat **48** is mounted on another vertical column **50,** which is coupled to the pivot joint **46.** Suitable bracing **52** extends between the vertical column **44** and another spaced vertical column **54** is carried adjacent the front portion of the ergometer. Extending upwardly from the vertical column **54** and coupled thereto by a pivot joint **56,** is still another column **58** into which handle bars **60** are suitably carried. Positioned on top of the handle bars **60** is a console **62** having a front panel **64** which includes appropriate meters and controls sufficient to enable the operator to observe the performance and work output, while peddling the load module **14.**

The apparatus constructed in accordance with the present invention is designed to give a dynamic calibration over a given speed range of the ergometer, and includes a D.C. motor **66** which is mounted on a steel platform **68.** The steel platform has wheels **70** mounted on the bottom thereof so that the apparatus can be readily maneuvered adjacent the ergometer. Vertically adjustable bolts **72** extend through threaded holes in the corners of the platform **68** so such can be screwed downwardly in order to raise the wheels **70** off of the supporting platform. Disc-shaped washers **74** are carried on the bottom of the bolts. When the bolts are screwed downwardly lifting the wheels **70** off of the floor such holds the supporting platform **68** in a fixed position on the floor.

The D.C. motor **66** has a shaft **74** extending outwardly therefrom to which a torque sensor **76** and a tachometer **78** are coupled in a conventional manner. The torque sensor **76** and tachometer **78** are suitably supported in an upwardly extending U-shaped member **80.** Extending out the other side of the U-shaped member **80** is a shaft **82,** which is coupled by means of a coupler **84** to the shaft **16** of the ergometer. It is noted that the peddles of the ergometer **10** have been removed for enabling the coupling of the shaft **16** to the shaft **82.** Any suitable coupling device may be used for coupling the shafts together.

After the platform **68** has been maneuvered alongside of the ergometer and coupled to the shaft **16** of the load module **14,** a speed controller **86** located in a control housing **88** is adjusted to supply sufficient power from any suitable power supply, such as shown at **90** to the D.C. motor **66.** At the particular speed set on the speed controller, the torque sensor **76** generates an electrical signal representing the torque produced by the D.C. motor **66** in rotating the load module **14** of the ergometer. The torque sensor may be any suitable conventional torque sensor, such as the one shown in U.S. Pat. No. 3,744,480, which incorporates strain gauges. The torque signal is fed into a power computer **91.** The electrical signal produced by the tachometer **78** is also fed to the power computer which may take the form of a multiplier that generates a direct current output representative of the rate of work being performed in rotating the load module of the ergometer. The analog signal from the multiplier is fed directly to a conventional recorder, and is also fed to an analog-to-digital converter whose output goes to digital readout unit on the power computer. The signal produced by the power computer **91** is compared with the output signal produced by the ergometer in order to determine if the ergometer is calibrated properly. Before starting the calibration tests, it is essential that the apparatus be properly calibrated by conventional means, such as lever arms and weights.

The output of the tachometer **78** is also fed back to the speed controller **86** so that a corrective signal can be fed over line **94** to the D.C. motor **66** for maintaining the D.C. motor at a constant speed. After the ergometer has been calibrated for one particular speed, the speed controller is adjusted to various speeds and the process is repeated.

One advantage of the apparatus constructed in accordance with the present invention over conventional static load calibrating systems is that the accuracy of such is not affected by heat generated by the load module, since the D.C. motor **66** is generally heated at the same rate.

While a preferred embodiment of the invention has been described using specific terms, such description is for illustrative purposes only, and it is to be understood that changes and variations may be made without departing from the spirit or scope of the following claims.

What is claimed is:

1. An apparatus for providing a dynamic calibration over a given speed range for an ergometer having a rotatable shaft coupled to a D.C. generator, a variable resistance load coupled to said generator, a first torque sensor sensing the torque required to rotate said shaft, a first tachometer for sensing the rate of rotation of said shaft, and means coupled to said first torque sensor and said first tachometer for generating an electrical signal representing the work being performed by the ergometer, said apparatus comprising:

a. a D.C. motor adapted to be coupled to said shaft for rotating said shaft;

b. a second torque sensor coupled to said shaft producing a torque signal indicating the torque required to rotate said shaft;

c. a second tachometer coupled to said shaft generating an electrical signal indicating the speed of rotation of the shaft;

d. means coupled to said second torque sensor and said second tachometer for generating an electrical signal indicating the work being performed by said D.C. motor in rotating said shaft;

e. a speed controller coupled to said D.C. motor for causing said D.C. motor to be rotated at predetermined speeds, and

f. a feedback circuit coupled between said second tachometer and said speed controller supplying a signal to said speed controller so as to maintain the rate of rotation of said D.C. motor constant for a predetermined setting of said speed controller,

whereby by comparing the electrical signal representing work generated by said ergometer with said electrical signal of said apparatus at various speeds of rotation of said shafts it can be determined if said ergometer requres calibration.

2. The apparatus as set forth in claim **1** further comprising:

a. a carriage supported on a surface;

b. means for mounting said D.C. motor on said carriage;

c. said D.C. motor having a rotatable shaft extending outwardly therefrom, and

d. a mechanical coupling connecting said shaft of said D.C. motor to said shaft of said D.C. generator.

3. The apparatus as set forth in claim **2** further comprising:

a. rotatable wheels supporting said carriage for enabling said carriage to be maneuvered adjacent said ergometer, and

b. adjustable vertically extending legs carried by said carriage for engaging said surface to lock said carriage in position.

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